MEMORANDUM | September 1, 2015

TO Craig O'Connor, NOAA

FROM Eric English, Chris Leggett, and Kenneth McConnell

SUBJECT E2 - Value of Travel Time and Income Imputation

INTRODUCTION

The value of travel time is a component of the price of a recreation trip in models that value outdoor recreation. In the shoreline, boating and infield valuation models, the value of travel time was calculated by dividing the respondent's annual household income by 2,080 and multiplying the result by one third. Dividing by 2,080 follows Department of Transportation guidance (U.S. Department of Transportation 2014) and other precedents for converting annual income into what is sometimes called "hourly" income. Using 1/3 of hourly income as the value of travel time is consistent with research in the economics literature, which is described below. Household income was reported by survey respondents for the calendar year prior to the interview date, and respondents were directed to include all income from wages, salaries, interest and other income.

The first section below presents a review of research and precedents relevant to valuing travel time in recreation models. Sources that were determined to provide reliable evidence are highlighted, and adjustments are applied to express previous results in terms applicable to the Deepwater Horizon models. Articles that were reviewed but determined to be less reliable are also described, and the reasons for this judgment are provided. The second section below discusses one of the adjustments to the value of travel time in additional detail, namely, an adjustment that accounts for children in the value of time. The final section discusses household income data used to value travel time, and describes methods for imputing incomes for survey respondents who did not provide a specific income amount.

RESEARCH AND PRECEDENTS FOR THE VALUE OF TRAVEL TIME

In models that value recreation trips, the cost of traveling to a recreation site includes both monetary expenditures, such as gasoline and tolls, and the value of time spent traveling. The value of travel time represents a cost because many people prefer not to spend time driving, flying, or waiting in airports. The amount someone would be willing to pay to avoid or reduce time spent traveling, and instead spend the time on a freely chosen activity, is the value of travel time.

There are two indications of the appropriate value of travel time for recreation models. The first is evidence in the literature from published studies that have measured the value of travel time. Research on the value of travel time is reviewed in detail below. A second indication involves precedents and common practice in the literature. This is the value for travel time authors typically use as an input to recreation models, even when they do not directly estimate the value themselves.

In a review of the recreation literature, 65 studies were identified that provided specific information on what value for travel time was used. Of these, 46 percent used 1/3 of some measure of hourly income for the value of travel time. This was the most common practice. Of studies that did not use 1/3 of hourly income, most used either a zero value for travel time or the full amount of hourly income. These two practices may best be viewed as placeholders in studies likely to emphasize other aspects of valuation methodology. After excluding studies that used a zero value or full hourly income, 91 percent used 1/3 of hourly income. Examples of studies that have used 1/3 hourly income include Train (1998), Parsons et al. (2000), Moeltner (2003), and Parsons et al. (2009).

A review of articles and other sources that provide specific evidence on the value of travel time is described in the next section. In the review, three potential adjustments were applied. The first adjustment involves controlling for the way income was measured in the source document relative to the way income was measured in the shoreline, boating, and infield valuation models. For example, in the Deepwater Horizon models income was measured as hourly household income. If a source document measured the value of travel time as a proportion of hourly personal income, the reported proportion was adjusted downward for application to the Deepwater Horizon models. This accounts for the fact that household income is on average higher than personal income.

The second adjustment involves controlling for the use of median versus average income. A source document may report the value of travel time as a proportion of median income. Using the median rather than the average reduces the influence of high income values. Like most recreation models, the Deepwater Horizon models used individual-specific incomes for each respondent, a practice that retains the influence of all income levels to estimate an average value for recreation trips. For this reason it may be more appropriate to express the value of time as a proportion of average income rather than median income for application to the Deepwater Horizon models. If a source document expressed the value of time as a proportion of median income, the proportion was adjusted downward to account for the fact that average income is typically higher than median income.

The third adjustment involves controlling for whether children are included in a recreation model. The Deepwater Horizon models include children as well as adults. Specifically, both costs and value in the models are distributed across all people, including children. The resulting per-trip values can therefore appropriately be applied to recreation estimates from the aerial photographs and other infield surveys, which represent all shoreline visitors, including both adults and children. If a source document measured the value of time by allocating value to adults only, a downward adjustment in the value of time is required. Specifically, the value of time was summed over adults and reallocated to all people, including children. This is equivalent to multiplying the value of travel time for adults by a fraction representing the proportion of adults in the population.

DEPARTMENT OF TRANSPORTATION GUIDANCE

The first source for the value of travel time is a memorandum released by the U.S. Department of Transportation (DOT) titled "Revised Departmental Guidance on

Valuation of Travel Time in Economic Analysis" (U.S. Department of Transportation 2014). According to the memorandum, the guidance is intended to assist in "evaluating the benefits of infrastructure investment and rulemaking initiatives". The memorandum summarizes and evaluates the results of research in the United States and internationally on the value of travel time, and makes recommendations.

The DOT guidance distinguishes personal travel from business travel. Personal travel includes commuting, recreation, shopping, and travel for other non-business purposes. The guidance also distinguishes between local travel and intercity travel, as described below. The DOT memorandum indicates that some research and precedents have made other distinctions, for example, suggesting lower values of travel time for recreation trips relative to commuting trips, or lower values for children relative to adults. However, the DOT guidance applies the same value to all types of personal travel and to all people in a vehicle. The DOT guidance is presented as a proportion of median hourly household income, where hourly household income is household income divided by 2,080.

For local travel, DOT recommends using 50 percent of median hourly household income as the value of travel time. For intercity travel, DOT recommends using 70 percent of median hourly household income as the value of travel time. The guidance applies these values to all types of personal travel time for both adults and children. The guidance does not specifically define the distinction between local and intercity travel.

Interpreting the DOT recommendations in the context of recreation models may require an adjustment, as described above. The common practice in the recreation economics literature does not use median income to estimate the value of travel time, but uses the actual incomes reported by respondents to a recreation survey. While the use of median income reduces the influence of high income values, the use of individual-specific incomes retains the influence of all levels of income to estimate an average value for recreation trips. For this reason, expressing the DOT recommendations as a proportion of average income rather than median income may result in a more appropriate basis for valuing travel time in the context of recreation models.

The DOT recommendations can be adjusted from a proportion of median income to a proportion of average income based on the difference between median and average U.S. household income. In 2013, median household income was $51,939, and average household income was $72,641 (U.S. Census Bureau 2014). Since average income was 1.40 times higher than median income (72,641 / 51,939 = 1.40), the value of travel time expressed as a proportion of average income would be lower by a factor of 1/1.40. Dividing the DOT recommendations of 50 percent and 70 percent by 1.40 results in adjusted proportions of 35.8 percent and 50.1 percent. Since the DOT recommendations use hourly household income and include children, as the Deepwater Horizon model do, no other adjustments are required.

In Deepwater Horizon valuation models, recreation trips involve both local and intercity travel. The value of travel time for all trips in the valuation model was calculated as 1/3, or 33.3 percent, of hourly household income (where the conversion from annual to hourly income is also 2,080). This is slightly below the range of 35.8 percent to 50.1 percent presented in the DOT guidance.

SELECTED ARTICLES FROM THE RECREATION ECONOMICS LITERATURE

The studies reviewed in this section were determined to provide potentially reliable information on the value of travel time for recreation. A caveat to this review is that it is not possible to evaluate all aspects of a study based on details provided in a published article. Also, it is possible that not all articles that estimate a value for travel time were identified for this review. Articles published before 1990 were specifically excluded.

The articles included in this section are Fezzi et al. (2014), Hausman et al. (1995), Larson and Lew (2014), and McKean et al. (1995). Other studies in the recreation economics literature that have developed estimates for the value of travel time, but were not used in our choice of the value of travel time for the Deepwater Horizon assessment, are reviewed in the next section.

Fezzi et al. (2014)

This article estimated the value of travel time for people driving to a recreation site based on the choices they make between faster toll roads that save time and free roads that are slower. They found the average willingness to pay to save time was €8.58 per hour. This amount was calculated by estimating the value of travel time per vehicle and allocating it across adults in a vehicle, which the study defined as people greater than 16 years old. In the Deepwater Horizon assessment, a value for travel time was applied to all people in a vehicle, including children. To obtain a value applicable to the Deepwater Horizon models, the value reported in Fezzi et al. must be summed over adults and reallocated across all people in a vehicle. Information specific to the study area was not available, but the proportion of people older than 16 in Italy is 84.1 percent (OECD 2015). This implies an adjusted value of travel time of approximately €7.22 (8.58 x 0.841 = 7.22).

The Fezzi et al. article did not report the household income of vehicle passengers in the study, or of households in the study area. Estimates of gross average household income in Italy could not be located for this memorandum. Instead, average household income in Italy can be approximated using related data. Average household income in the United States in 2013 was $72,641 (U.S. Census Bureau 2014). In 2012, per-capita GDP was $35,132 in Italy compared to $51,495 in the United States (World Bank 2015). Multiplying $72,641 by 0.68 (35,132 / 51,495 = 0.68) and converting to euros at the average exchange rate for the past year of 1.24 (Federal Reserve 2015) results in an estimated average household income in Italy of €39,870. This can be compared to the average after-tax household income of €30,380 reported by the Bank of Italy (2014). The value of travel time as a proportion of hourly household income is therefore 37.7 percent (7.22 / (39,870 / 2,080) = 0.377).

Hausman et al. (1995)

This article estimated recreational fishing losses to Alaska residents from the 1989 Exxon Valdez oil spill. The article included a model in which recreators choose among several transportation modes for reaching a recreation site. The modes included car, car and commercial airline, and car and ferry, among other options. Monetary costs and travel time varied across the mode options available to each person. Based on the mode selected for each trip, the model estimated the average tradeoff between time and money for recreation travel, which is the value of travel time. The result was $5.34 per hour.

The article did not specify whether children were included in the model of travel time, though the use of air and ferry travel among the transportation modes suggest that children, who would likely require a ticket in these cases, may have been at least partly included. Median household income in Alaska in 1989 was $41,408 (U.S. Census Bureau 2015), so the estimated value of travel time is equivalent to 26.8 percent of median hourly household income (5.34 / (41,408 / 2080) = 0.268). Statistics on average household income in Alaska were not available for this memorandum, but the current ratio of average to median household income for the U.S. is 1.40, as cited above. This implies an estimated value of travel time, as a proportion of average hourly household income, of 19.2 percent (26.8 / 1.40 = 19.2).

Larson and Lew (2014)
This article estimated the value of travel time in a model of recreational salmon fishing in Alaska. There was variation in the monetary cost and amount of time to reach each site, and the tradeoff between monetary cost and time, or the value of travel time, was estimated.[1] The study includes two models, one where the value of travel time is a fixed proportion of the wage, and another where the value of time is represented by a proportion of the wage that varies over a random distribution. The study did not specify how the wage was calculated, for example, whether it was equal to hourly household income. The article also did not specify whether children were included in the model.

The first model, using a fixed proportion of the wage, resulted in a value of time equal to 33.3 percent of the wage rate. Using a fixed proportion of some measure of income is the common practice for valuation models in the economics literature, and the valuation models for the Deepwater Horizon assessment also followed this practice. The second model resulted in a value for travel time equal to 46.8 percent of the wage rate, which is the mean of the estimated distribution. Despite the higher average value of travel time, the second model obtained slightly lower estimates of the value of recreation. The 33.3 percent from the first model is more consistent with model specifications in the literature, and is more applicable to the valuation methods used for this assessment.

McKean et al. (1995)
A model was developed for recreational fishing trips to a reservoir in Colorado. The value of travel time was estimated based on variation in the relationship between travel time and monetary expenses for trips from different origins. (The article also estimated a second model was not considered for this review because it set the value of travel time

[1] Many articles used this type of approach to valuing travel time. In this approach, the number of trips people take is modeled as a response to the price of trips, as in any travel cost model. The price of trips is modeled as a combination of monetary and time costs. People from different origins face different combinations of money and time costs to reach a site. This variability allows the model to estimate the importance of travel time relative to monetary costs, in other words, it allows an estimate of the value of travel time to be obtained. For example, if a $10 change in monetary costs is found to have the same effect on the demand for trips as a one-hour change in travel time, then the value of travel time is $10 per hour.

equal to hourly income for people with flexible work hours, based on the unsupported assumption the people dislike work time and travel time equally.) The article did not describe the measure of income used, but the average value of income was reported as $32,415 in 1986. This compares to a median household income in the United Stated of $24,897 in 1986 (U.S. Census Bureau 1988).

The model is associated with some uncertainties, for example: the model was based on data collected on site, but the weighting methods, which can be complex for onsite surveys, were not described; the model used a truncation correction, which is potentially unreliable because it depends on modeling assumptions to fill in observations for all people not recreating at the site, observations that are missing when data is collected on site; and while the value of time was estimated for all trips to the main site in the model, the variable definitions suggest that time was fixed at full hourly income for travel to the nearest substitute site, although this may have been typographical error.

The value of travel time was estimated to be 46.1 percent of hourly income. The article states that the monetary expenses of travel were divided among people in a party who shared expenses, suggesting that children were excluded. To obtain a value applicable to the Deepwater Horizon models, the value must be added up over adults and reallocated across all people, including children. The proportion of people under 18 in the United States is currently 23.3 percent (U.S. Census Bureau 2015b). While this represents only an approximation of the proportion of children taking fishing trips in Colorado, it implies an adjusted value of travel time of 35.4 percent of average hourly household income (46.1 x (1 - 0.233) = 35.4).

OTHER ARTICLES FROM THE RECREATION ECONOMICS LITERATURE

The articles reviewed in this section provide estimates of the value of travel time that we have not used in our choice of the value of travel time for the Deepwater Horizon assessment.. The reasons for making this judgment are provided for each article below, along with an overview of the methods used in each study.

Amoako-Tuffour and Martinez-Espineira (2012)

This article analyzed the value of recreation trips to a national park in Newfoundland using data collected on site. The value of travel time was estimated based on variation in the relationship between travel time and monetary expenses for trips from different origins. The value of time was estimated to be between 0.8 percent and -6.7 percent of hourly income, the latter value indicating that people prefer longer travel times to shorter travel times. The analysis contained a variety of approximations and uncertainties, including:

- Onsite sampling methods that did not account for the higher probability of interviewing respondents with longer visit durations;

- A five-year recall period for survey questions about the number of trips respondents took, together with the assumption that respondents did not move during that time;

- An incorrect estimate of the quantity of trips, specifically, treating the product of trip frequency and party size as the dependent variable in a model of individual demand;

- An approximation of the monetary cost and travel time for flying based on a linear function of distance. Specifically, the authors assumed the cost of flying was $0.20 per kilometer for one-way distances less than 4,000 kilometers and $0.10 per kilometer for one-way distances greater than 4,000 kilometers. They calculated travel time for all flights as round-trip distance divided by 600 kilometers per hour. About 38 percent of survey respondents flew;

- Reliance on problematic assumptions to control for truncation of non-recreators in an onsite sample. Specifically, the number of people from a given origin who chose not to visit the park was estimated within the model using an assumed relationship between the observed number of visits to the park and the unobserved proportion of people not visiting the park.

This estimate of the value of travel time was not relied upon for the Deepwater Horizon assessment. Although none of the issues cited above directly lead to a known bias in the estimated value of travel time, the combined effect of these approximations introduces excessive uncertainty in model results.

Englin and Shonkwiler (1995)
This article analyzed the value of recreation trips to Lake Champlain in New York State. Data were taken from the National Acid Precipitation Assessment Program, and the value of travel time was estimated based on variation in the relationship between travel time and monetary expenses for trips from different origins. Some problematic methods were employed, including discarding data on the number of people choosing not to take trips to Lake Champlain, and then filling in for the missing data using a model-based truncation correction.

The article provided two estimates of the value of travel time. One estimate is $11.77 per hour, and the other estimate is 39.7 percent of the wage rate. The article did not specify what measure of income was used as the wage rate. Also, the two estimates were calculated from separate parameters in the same travel cost model, and it was not clear from the article whether these estimates represented two alterative measures of the value of travel time, or whether they were additive and should be combined into a single estimate of the value of travel time. The model used to estimate the value of travel time resulted in lower trip-value estimates than an alternative model that applied the assumption of 1/3 the wage rate as the value of travel time.

This estimate of the value of travel time is was not relied upon for this assessment because of insufficient clarity in the description of methods and results.

Feather and Shaw (1999)

Using data from the 1994 National Survey of Recreation and the Environment (NSRE 1994), this study estimated the "shadow wage" for survey respondents, which is the amount someone would need to be paid to spend additional hours working. The study used the shadow wage as the value of travel time in a travel cost model, relying on a model of labor supply . Some economists have questioned whether the value of travel time for recreation is related to labor market decisions (Hausman et al. 1995). According to the study, the average value of travel time was found to be 90.5 percent of hourly personal income.

The estimate of the value of time was not relied upon for this assessment because it is not based on the trade-off between money and travel time.

Larson (1993)
The value of travel time was estimated for anglers fishing at a river in Alaska. The analysis did not rely on an empirical model, but calculated the value of time for each fishing trip as the quotient of two terms. The first term was the monetary travel cost for a given trip, such as the cost of gasoline, minus the monetary onsite cost for the trip, such as camping fees. This term was divided by onsite time minus travel time in the denominator. This formula cannot be considered valid, because in cases where onsite time and travel time are approximately equal, a plausible situation, the denominator of the formula approaches zero and the value of time approaches infinity, although apparently such extreme observations were discarded. The article reported an average value of time of $2.54 per hour, or 16.0 percent of the average hourly household income of $15.87.

This estimate of the value of time was not relied upon for this assessment because of implausible implications of the methods.

Lew and Larson (2005)
This article estimated the value of travel time using a combined model of labor supply decisions and beach recreation in the San Diego region. The link between labor supply and travel time was based on the assumption that people dislike work time and travel time equally. The article reported the value of travel time by several labor-class categories, such as full-time workers and part-time workers, but did not appear to provide an average value for travel time. However, the large majority of survey respondents included in the model fell into labor categories with values at least as great as $11.19, the value reported for retirees. Given the reported average household income for the sample of $62,698, the average value of travel time appeared to be at least 37.1 percent of average hourly household income (11.19 / (62,698 / 2080) = 0.371).

The estimate of the value of time was not relied upon for this assessment. It is based on a labor market model that may not give appropriate values for recreational travel time.

Loomis et al. (2000)
A model was developed for whale-watching trips to four sites on the California coast. Interviews were conducted with parties completing their visits at each of the four sites. Three of the four sites had the option of boarding a whale-watching boat, although whale

watching from shore also appeared to be an option at all four sites. The value of travel time was estimated using five different models and was based on variation in the relationship between travel time and monetary expenses for trips from different origins.

The article did not specifically report an estimate for the value of travel time, and because the value was based on both a linear and a squared term, an average value for travel time cannot be calculated without information about the distribution of travel times for survey respondents. However, as an illustration, the model based on trips whose primary purpose was whale watching gives estimates of the value of travel time of $14.87, $14.36, and $13.85 for one-hour, two-hour, and three-hour round-trip journeys, respectively. The median household income in California in 1989 was $35,798 (U.S. Census Bureau 2015). Adjusting by the factor of 1.4 (cited above) to convert median income to average income, and dividing by 2,080 hours, provides an estimate of average hourly household income of $24.07. The estimated value of travel time as a proportion of average hourly household income was therefore 61.8 percent, 59.7 percent, and 57.5 percent for one-hour, two-hour, and three-hour journeys, respectively.

A significant limitation of the study is the fact that fees for boarding a whale-watching boat were included with travel cost, apparently with no adjustment to account for the fact that those paying the fees also obtained the value of whale watching from a boat. Depending on the size of the fees relative to travel cost, this could cause a significant upward bias in estimates of the value of travel time due to a downward bias in the coefficient on travel cost. Also, the use of onsite data inappropriately excludes information about the number of people choosing not to take whale watching trips from throughout the study area, and involves complex weighting methods that were not described and therefore cannot be evaluated.

This estimate of the value of travel time was not relied upon for this assessment because of bias likely to result from including onsite boat-tour fees in the travel-cost variable.

Morey et al. (2002)
A model of trout fishing at 26 sites in southwestern Montana was developed. Monetary costs included both travel costs, such as expenditures on gasoline, and onsite costs, such as expenditures for lodging. Time costs included both travel time and onsite time. The value of time was estimated based on variation across individuals in the relationship between the time and monetary components of cost.

Combining onsite time with travel time requires the assumption that both are valued equally. This is problematic becauseonsite time would have to be viewed as enjoyable for people to take recreation trips at all, while travel time would have to be disliked in order to be included as a component of price. The value of time was estimated to be 11 percent of the wage rate. The article did not specify what measure of income was used as the wage rate.

This estimate of the value of travel time was not relied upon for this assessment because of the uncertain impact of onsite costs on the estimated value of travel time.

Palmquist et al. (2010)
Using data from a survey of homeowners in Wake County, North Carolina, this study estimated the "shadow wage" for survey respondents, which is the amount someone would need to be paid to spend additional hours working. The study adjusted the shadow wage to account for the length of time spent recreating, based on the concept that more time recreating makes each hour of recreation more costly. The resulting average cost of time was 70 percent of the observed wage rate. The article did not specify what measure of income was used as the observed wage.

The adjusted shadow wage was applied to both travel time and onsite time, based on the implicit assumption that both travel time and onsite time have the same disutility as work time. This estimate of the value of travel time came from a paper that was methodological in orientation. The estimate of the value of travel time would best be regarded as exploratory, and not a useful guide for choosing the value of time in the Deepwater Horizon assessment.

CHILDREN AND THE VALUE OF TRAVEL TIME
As discussed in Technical Memo E1 – Travel Cost Computation, travel costs are calculated by combining the value of travel time with out-of-pocket costs such as gasoline (in the case of driving) and airplane tickets (in the case of flying). All these costs are calculated on a per person basis, and the estimated per-person user-day value is applied to lost user days for all people, including children.

Calculating costs on a per-person basis is appropriate for this assessment because it is consistent with the infield surveys and aerial photographs, which result in a count all people on the shoreline. For comparison, one could consider calculating costs on a per-adult basis and applying the resulting user-day value only to the user days of adults. To calculate costs on a per-adult basis, out-of-pocket travel costs would have to be distributed only across adults. This would include reassigning to adults the airfares for flights taken by children. The value of travel time would also have to be allocated to adults only, resulting in a value for time that is higher than one-third of hourly household income.

While the decision to exclude children from the valuation model would affect the value per recreation visit, in most models it would not affect the total value of recreation. This is because the choice to allocate costs and value only to adults increases the value per user day, but decreases, by the same proportion, the number of people to whom the value is applied. This is necessarily true in any model that uses a single average party size to determine costs per person, as the Deepwater Horizon models do. Models that estimate costs per person using something other than average party size may exhibit either an increase or decrease in the total value of recreation when children are excluded.

Assuming per-person costs are calculated using average party size, let ρ represent the fraction of hourly household income that is appropriate when valuing the travel time of all visitors. Let ρ' represent the fraction of hourly household income that would be appropriate when valuing only adult travel time (e.g., in a model of adults only). Also, let

a represent the average number of adults per vehicle, let s represent the average number of people per vehicle including children, and let k represent per mile out-of-pocket costs for a recreation party. In the Deepwater Horizon assessment, per-person travel costs are[2]

$$cost/person = \rho * hourly\_income * time + \frac{distance*k}{s}.$$

The analogous *per adult* cost would be

$$cost/adult = \rho' * wage\_rate * time + \frac{distance*k}{a}.$$

If we let $\rho' = \rho({}^{S}/_{a})$, then the per-adult cost is simply s/a multiplied by the per-person cost. Since all travel costs are scaled up proportionately by s/a, the estimated adult user-day value is greater than the per-person user-day value by the factor s/a. Since the per-adult value applies to a/s fewer people than the per-person value, there is no change in the total recreation value.

INCOME IMPUTATION

Approximately 69 percent of respondents in the national valuation survey provided a specific amount in response the question about their annual household income. In the local valuation survey, 66 percent of respondents provided a specific income amount. The remainder either did not answer the question (9 percent of respondents in the national survey and 12 percent of respondents in the local survey) or provided bounds rather than an exact dollar figure (22 percent in the national survey and 23 percent in the local survey). When an exact amount was not provided, household income was imputed using the approach described below.

The procedure used for income imputation closely follows the approach applied by the Center for Disease Control and Prevention in imputing income data for the National Health Interview Survey (Schenker et al., 2006; Schenker et al. 2013). The procedure was implemented independently for the national survey, the local boating survey, and the local shoreline survey.

1. First, for respondents who provided point estimates for household income, the cube root of income is regressed on demographic characteristics, survey design variables, survey weights, and coastal recreation trips. Letting Y_i represent the income of respondent i and letting $\tilde{Y}_i$ represent the cube root of Y_i, the regression can be written as:

   $$\tilde{Y}_i = \alpha + \beta X_i + \varepsilon_i$$

   The explanatory variables included in X are described in Exhibit 1.

[2] For simplicity, we omit tolls, hotel costs, and flying costs. The results do not change when these additional costs are included.

EXHIBIT 1. EXPLANATORY VARIABLES USED IN INCOME IMPUTATION REGRESSIONS

VARIABLE	DEFINITION
trips	Total number of coastal recreation trips reported by respondent
trips_squared	Square of coastal recreation trips reported by respondent
partn	= 1 if no one in respondent's household participated in coastal recreation in GA, FL, MS, AL, LA, or TX within the 12-month period prior to receiving the mail screener (= 0 otherwise)
ownb[a]	= 1 if respondent indicated on the survey that he owned one or more boats (= 0 otherwise)
boatf[a]	= 1 if respondent's address was drawn from the boater registration list (= 0 otherwise)
wgt	Annual sampling weight associated with the observation
wgt_squared	Square of the annual sampling weight
gstrat_UN[b]	= 1 if respondent's address was selected from an under-sampled geographic stratum (California) (= 0 otherwise)
gstrat_OV[b]	= 1 if respondent's address was selected from an oversampled geographic stratum (IN, KS, KY, MI, MO, OH, TN, or GA) (= 0 otherwise)
age	Age of respondent
age_squared	Age of respondent squared
mu18	Family members under the age of 18 living in the respondent's household
mo18	Adults age 18 or older living in the respondent's household
caucasian	= 1 if respondent is non-Hispanic and non-black (= 0 otherwise)
male	= 1 if respondent is male (= 0 otherwise)
urban	Percent of respondent's zip code that is classified as urban
mhome	= 1 if respondent has a second home (= 0 otherwise)
incqX (X = 2,3,4)	= 1 if respondent's census block group falls within the Xth quartile (within the sample) of mean census block group income (= 0 otherwise)[c]
eeX (X= 2,3,…,12)	Dummy variables representing the interaction of employment status (four categories - working full time, working part time, retired, or other) and education (three categories - high school or less, some college, or college graduate or higher)
rX (X = 2,3,…,9)[b]	Dummy variables for the nine census divisions indicating the location of the respondent's main home (based on the sampled address)
sX (X = 2,3,4,5,6)[a]	Dummy variables for the six Gulf Coast area states indicating the location of the respondent's main home (based on the sampled address)

Notes:

a This regressor was included only when imputing income for respondents in the local (boating and shoreline) survey.

b This regressor was included only when imputing income for respondents in the national survey.

c For the national survey, the following cut points were used to define the four quartiles: $57,258.2 (25th percentile), $75,033.6 (50th percentile), and $96,633.4 (75th percentile). For the local survey, the following cut points were used to define the four quartiles: $48,417.0 (25th percentile), $60,138.8 (50th percentile), and $75,643.7 (75th percentile). Sampling weights were not used in calculating these income cut points.

2. Next, a single set of parameter values was randomly drawn from the joint distribution of the estimated regression parameters, using the following two-step procedure:

   a. A single, randomly-drawn value for the error variance (σ_*^2) was obtained by dividing the residual sum of squares by a random draw from a chi-squared distribution with degrees of freedom equal to the regression model degrees of freedom.

   b. A single vector of parameter values (β_*) was randomly drawn from the following multivariate normal distribution:

$$N\left(\hat{\beta}, \sigma_*^2(X'X)^{-1}\right)$$

3. After drawing parameter values, cube-root income was imputed using one of two methods, depending on the amount of information provided by the respondent. (When the respondent provided a point estimate for income, no imputation was performed and the point estimate was used in the analysis.)

   a. Income Missing: For cases where the respondent provided no income information at all, a predicted value of $\hat{\tilde{Y}}_i$ was obtained by drawing from $N(X_i\beta_*, \sigma_*^2)$.

   b. Income Missing but Bounds Available: For cases where the respondent provided lower (ai) and/or upper (bi) bounds, a predicted value of $\hat{\tilde{Y}}_i$ was obtained by drawing from a truncated normal distribution with density function given by:

$$f(\tilde{Y}_i) = \frac{\varphi\left(\frac{\tilde{Y}_i - X_i\beta_*}{\sigma_*}\right)}{\Phi\left(\frac{b_i - X_i\beta_*}{\sigma_*}\right) - \Phi\left(\frac{a_i - X_i\beta_*}{\sigma_*}\right)}, \qquad a_i < \tilde{Y}_i < b_i$$

4. If the imputed cube-root income ($\hat{\tilde{Y}}_i$) was less than zero, it was replaced with zero.

5. The imputed cube-root income was cubed to obtain the final predicted income for respondent i:

$$\hat{Y}_i = \hat{\tilde{Y}}_i^{\,3}$$

6. Steps 2 through 5 were repeated to obtain additional sets of imputed incomes for use in variance calculations.

INCORPORATING INTERVIEWER (CONTROL K) COMMENTS

A small number of respondents provided supplemental information regarding income in the form of open-ended comments to interviewers[3]. These are referred to as "control k" comments, as interviewers needed to type <control> *k* to record the comments during the interview. Control k comments relevant to income were reviewed, a set of control k income variables were created based on this review, and the control k income variables were combined with income data from the standard survey questions to develop final point estimates and bounds prior to income imputation.

Based on the review of control k comments, alternative point estimates or lower/upper bounds for income were developed. These are referred to as control k income variables. In creating control k income variables, the following rules were followed:

1. If a lower bound was provided without an upper bound, then the lower bound was treated as the control k point estimate.
2. If an upper bound was provided without a lower bound, then zero was used as the control k lower bound.
3. If the respondent provided some indication that the household income was unusually low (i.e., due to comments about disability, food stamps, etc.), then the control k upper bound was set at $25,000.
4. If the upper and lower bounds differed by less than $25,000, then the bounds were discarded and the midpoint was treated as the control k point estimate.

These control k point estimates and bounds were combined with income data from the standard survey questions as follows:

1. <u>Income Missing</u>: When the respondent provided no income data on the standard survey questions, the control k response was used, where feasible, to provide either a point estimate for income or income bounds.
2. <u>Income Missing but Bounds Available</u>: When the respondent provided bounds for income on the standard survey questions, the control k response was used, where feasible, to replace the bounds with a point estimate or to restrict the range of those bounds, as follows:
    i. If a control k point estimate was provided and it was consistent with the bounds provided in the standard survey questions, the control k point estimate was used and the bounds were discarded.
    ii. If a control k point estimate was provided and it was not consistent with the bounds provided in the standard survey questions, the control k point estimate was discarded.
    iii. If the control k lower bound was higher than the lower bound provided in the standard survey questions, then the control k lower bound was used.

[3] See Technical Memo E7 - Interviewer Comments for a more detailed discussion.

iv. If the control k upper bound was lower than the upper bound provided in the standard survey questions, then the control k upper bound was used.

3. Income not Missing: When the respondent provided a point estimate for income, the control k point estimates and lower bounds were not used. However, if the control k comment indicated that the income response was partial (i.e., did not include income for one or more adults in the household), then this point estimate was treated as a lower bound.

REFERENCES

Amoako-Tuffour, J. and R. Martinez-Espineira. 2012. Leisure and the Net Opportunity Cost of Travel Time in Recreation Demand Analysis: An Application to Gros Morne National Park. *Journal of Applied Economics* 15:25-49.

Bank of Italy. 2014. *Supplements to the Statistical Bulletin: Household Income and Wealth in 2012*. Bank of Italy. January. Available at: https://www.bancaditalia.it/pubblicazioni/indagine-famiglie/bil-fam2012/engl_suppl_27_2014.pdf?language_id=1

Englin, J., and J.S. Shonkwiler. 1995. "Modeling recreation demand in the presence of unobservable travel costs: Toward a travel price model." *Journal of Environmental Economics and Management* 29(3):368-377.

Feather, Peter, and W. Douglass Shaw. 1999. "Estimating the Cost of Leisure Time for Recreation Demand Models." *Journal of Environmental Economics and Management* 38: 49-65.

Federal Reserve. 2015. *U.S. / Euro Foreign Exchange Rate*. Federal Reserve Economic Database. Available at: https://research.stlouisfed.org/fred2/search?st=U.S.+%2F+Euro+Foreign+Exchange+Rate. Accessed May 24, 2015.

Fezzi, C., I. Bateman, and S. Ferrini. 2014. Using Revealed Preference to Estimate the Value of Travel Time to Recreation Sites. *Journal of Environmental Economics and Management* 67:58-70.

Hausman, J., G. Leonard, and D. McFadden. 1995. A Utility-Consistent Combined Discrete Choice and Count Data Model Assessing Recreation Use Losses Due to Natural Resource Damage. *Journal of Public Economics* 56:1-30.

Larson, D. 1993. Joint Recreation Choices and Implied Values of Time. *Land Economics*. 69:270-286.

Larson, D., and D. Lew. 2014. The Opportunity Cost of Travel Time as a Noisy Wage Fraction. *American Journal of Agricultural Economics* 96(2):420-437.

Lew, D., and D. Larson. 2005. Accounting for Stochastic Shadow Values of Time in Discrete Choice Recreation Demand Models. *Journal of Environmental Economics and Management* 50:341-361.

Loomis, J., S. Yorizane, and D. Larson. 2000. Testing Significance of Multi-Destination and Multi-Purpose Trip Effects in a Travel Cost Method Demand Model for Whale Watching Trips. *Agricultural and Resource Economics Review* 29:183-191.

McKean, J.R., D.M. Johnson, and R.G. Walsh. 1995. "Valuing Time in Travel Cost Demand Analysis: An Empirical Investigation." *Land Economics* 71:96-105.

Morey, E., W. Breffle, R. Rowe, and D. Waldman. 2002. Estimating Recreational Trout Fishing Damages in Montana's Clark Fork River Basin: Summary of a Natural Resource Damage Assessment. *Journal of Environmental Management* 66:159-170.

Moeltner, K. 2003. "Addressing Aggregation Bias in Zonal Recreation Models." *Journal of Environmental Economics and Management* 45(1):128-144.

National Survey on Recreation and the Environment (NSRE). 1994. The Interagency National Survey Consortium, Coordinated by the USDA Forest Service, Recreation, Wilderness, and Demographics Trends Research Group, Athens, GA and the Human Dimensions Research Laboratory, University of Tennessee, Knoxville, TN.

OECD. 2015. *Total Population by Sex and Age.* Organization of Economic Cooperation and Development. Available at: https://stats.oecd.org/Index.aspx?DataSetCode=RPOP#. Accessed May 20, 2015.

Palmquist, R., D. Phaneuf, and V.K. Smith. 2010. "Short run constraints and the increasing marginal value of time in recreation," *Environmental and Resource Economics* 46: 19-30.

Parsons, G., A. Plantinga, and K. Boyle. 2000. "Narrow Choice Sets in a Random Utility Model of Recreation Demand." *Land Economics* 76(1):86-99.

Parsons, G., Kang, A., Leggett, C., and K. Boyle. 2009. "Valuing Beach Closures on the Padre Island National Seashore." *Marine Resource Economics* 24: 213-235.

Schenker, N., Raghunathan, T.E., Chiu, P.L., Makuc, D.M., Zhang, G., Cohen, A.J. Multiple imputation of missing income data in the National Health Interview Survey. *Journal of American Statistical Association*, *101*, 924-933. 2006.

Schenker N, Raghunathan TE, Chiu P, Makuc DM, Zhang G, Cohen AG. Multiple imputation of family income and personal earnings in the National Health Interview Survey: methods and examples. National Center for Health Statistics, Division of Health Interview Statistics. August 2013.

Train, K. 1998. "Recreation demand models with taste variation over people." *Land Economics* 74(2):230-239.

U.S. Census Bureau 2014. *Income and Poverty in the United States: 2013*. United States Census Bureau. September. Available at: https://www.census.gov/content/dam/Census/library/publications/ 2014/demo/p60-249.pdf

U.S. Census Bureau. 1988. *Money Income of Households, Families, and Persons in the United States: 1986*.

U.S. Census Bureau. 2015. *Median Household Income by State: 1969, 1979, 1989, 1999.* Available at: http://www.census.gov/hhes/www/income/data/historical/state/ state1.html. Accessed May 20, 2015.

U.S. Census Bureau. 2015b. State and County QuickFacts. Available at: http://quickfacts.census.gov/qfd/states/00000.html. Accessed July 17, 2015.

U.S. Department of Transportation. 2014. *Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis, Memorandum to Secretarial Officers and Modal Administrators*. United States Department of Transportation. July 9.

World Bank. 2015. *GDP per Capita.* The World Bank. Available at: http://databank.worldbank.org /data/views/reports/tableview.aspx?isshared=true. Accessed May 20, 2015.